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FIRM ENTRY AND POST-ENTRY PERFORMANCE IN THE U.S. CHEMICAL INDUSTRIES

by

Timothy Dunne*, Mark J. Roberts**, and
Larry Samuelson**

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*Center for Economic Studies, U.S. Census Bureau
**The Pennsylvania State University

Abstract

This paper examines the impact of entry on the structure of the U.S. chemical industries in the period 1963-1982. The paper measures both the immediate impact of entrants in terms of numbers, size and market shares and their subsequent growth and/or exit. Particular attention is devoted to the examination of entrant heterogeneity. The paper finds that while a large number of entrants appear in the chemical industries, they have a relatively small long-run impact. In addition, compared to previous work entrants are less important in the chemical industries than in the manufacturing sector as a whole. Finally, the post-entry performance of new firms varies significantly across different categories of entry.

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I. Introduction

The free and easy entry of new competitors provides the ultimate constraint on the exercise of market power by the firms in an industry. However, in practice the ability of firm entry to reduce or prevent noncompetitive market outcomes may depend not only upon the number of entrants but also on their size relative to the industry's incumbents and their ability to survive and grow.[1]

A number of recent papers suggest that an examination of the number of entrants in an industry is likely to exaggerate the impact of entry on the industry's structure because entering firms tend to be both small and short-lived. Hause and DuRietz (1984), MacDonald (1986), Baldwin and Gorecki (1987a, 1987b), and Dunne, Roberts, and Samuelson (1988b) find that the magnitude of entry is smaller when measured in terms of output or employment than when measured in terms of the number of firms. Dunne, Roberts, and Samuelson (1988b), for example, find that, on average across U.S. manufacturing industries, entering firms account for 38.6 percent of the number of firms but that each entrant produces only 15.8 percent of the average output level of incumbent firms. Evans (1987a, 1987b), Dunne, Roberts and Samuelson (1988a), and Pakes and Erikson (1988) find that failure rates are highest for small, young firms and decline with increases in age and size.[2] These findings suggest that small-scale entry often results in small-scale exit. Together, the relatively small size of entering firms and their high failure rates raise questions concerning the long-run impact of entry on market structure.

The impact of entering firms potentially depends not only on their initial size but also on the rate at which they grow after entering. The patterns of large firm growth have received substantial attention in the

enters the industry by opening a new plant or producing a new output in an existing plant. This will allow identification of entrants who have particularly influential effects on market structure.

The chemical industries were chosen for study because of their high rates of output and productivity growth over the 1967-1982 period, particularly when compared with other manufacturing industries.[5] The chemical industries also include a representative cross-section of U.S. manufacturing industries including several which are technologically sophisticated, such as biological products and pharmaceuticals, and others which are more traditional manufacturing operations such as paints and fertilizers.

The next section of this paper briefly outlines the theoretical model that organizes the empirical work. The model, which is developed by Jovanovic (1982), emphasizes heterogeneity in firms' costs. When combined with a market selection process this heterogeneity produces patterns of firm growth and failure in which relatively efficient firms survive and grow while inefficient firms contract and fail. Section III describes the data and the measurement of the entry and exit variables for the firms in the chemical industries. The data are developed from the plant-level data collected in the last five Census of Manufactures. These cover the years 1963, 1967, 1972, 1977, and 1982.

Section IV examines the incidence of entry in the chemical industries. We find a substantial number of entrants who, on average, account for approximately 45 percent of the firms in operation in each industry in each census year. However, entering firms have output levels which, on average, are only 22 percent of the level of the average firm in the industry and entrants collectively account for approximately 10 percent of industry output in each census year. We also find significant heterogeneity across entrant categories. New single-plant firms are the most numerous group of entrants

but diversifying, multi-plant firms make the largest contribution to industry output. On average, a diversifying multi-plant entrant is between five and eight times larger than a new single-plant entrant.

The post-entry performance of entering cohorts of firms is examined in Section V. Each cohort of entrants loses market share in the years following entry as the loss in cohort output from firm failure outweighs any output gains resulting from the growth of the surviving cohort members. The loss in both market share and numbers of firms is particularly large for single-plant entrants. The average size of the surviving multi-plant entrants increases with age, particularly for firms which entered by diversifying from other industries.

In section VI the observed increase in the average size of surviving members of an entry cohort is disaggregated into the effect of the growth in surviving entrants and the size difference between surviving and failing firms. Both firm growth and heterogeneity in the sizes of surviving and failing firms are found to play a role.

Section VII concludes. Three aspects of our results are noteworthy. First, large numbers of entrants appear in the chemical industries but these entrants appear to have little long-run impact. Second, comparison with previous work suggests that entrants are less important in the chemical industries than in the manufacturing sector as a whole. Finally, the post-entry performance of the new firms varies significantly across different categories of entrants.

II. A Model of Entry and Exit

The empirical analysis is guided by a model of industry evolution developed in Jovanovic (1982). The model is driven by a selection process in

which relatively efficient firms prosper and grow while inefficient ones contract and fail.

Each potential firm is characterized by three types of cost. An entry cost must be paid to enter the market. This cost is nonrecoverable and presumably includes expenditures for such things as product development, market research, introductory advertising, licensing, and product-specific production technology. A fixed cost must be paid in each period in which the firm remains in the market, regardless of the firm's output. This reflects the value of the firm's resources in alternative uses. Finally, the firm faces a variable cost-of-production function. This describes the variable cost of output as a convex function of the firm's output and a parameter, denoted c, which can be interpreted as the firm's efficiency level. High values of c identify inefficient firms with relatively high costs.

The selection model rests on two basic assumptions. First, each firm's variable costs are subject to random disurbances.[6] Second, firms in the market are characterized by different efficiency levels, or values of c, and hence different expected variable cost levels. It is further assumed that a firm cannot determine its efficiency level with certainty before entering the industry but, instead, forms a prior expectation concerning its likely efficiency level. The firm then learns about its efficiency level through the repeated observations on realized cost provided by its production over time. Because realized costs are subject to random fluctuations over time, the firm cannot learn its efficiency level immediately but instead learns this level gradually as it ages.

Given this cost structure, the market operates as follows. At the beginning of each period t, potential entrants assess their entry cost and expected efficiency levels and decide whether to enter the industry. Once

entry decisions have been made, firms choose output levels. These choices must be made before the level of period t variable costs have been revealed. If demand is subject to random fluctuations, output choices must also be made before the period t price is known. The output level is chosen to maximize expected profits and will be increasing in the expected period t price and decreasing in a firm's expected variable cost level. The period t price and period t variable cost levels are then realized and profits collected. Firms use their observations of actual period t costs to update, via Bayes rule, their expected efficiency levels. If the updating of the firm's expected costs leads to negative expected future profits, the firm exits the industry. The market now proceeds to period t+1, where the sequence is repeated.

This model directs attention to several factors which are likely to be important when empirically examining the process of entry and post-entry performance.[7] First, consider the effect of exogenous growth in industry demand. A firm in this model will enter the market if the expected profits from entering exceed the entry costs. Firms will remain in the industry rather than exit if the expected variable profits from remaining in the industry cover fixed costs. Both the expected profit from entering an industry and the expected variable profits from remaining in an industry may be higher if the industry is growing. This suggests that the rate of industry growth is likely to affect entry and exit rates. It is less clear that industry growth rates should affect the size of entering firms. If there are no costs to adjusting a firm's size then optimal size will depend only on current demand and will be independent of industry growth rates. If adjustment costs are important then optimal firm entry sizes are likely to increase with the growth in demand as firms build in anticipation of future demand growth.[8]

Second, consider the effect of an increase in a firm's age in the industry. The optimal size for a firm, at both the time of entry and in each period following entry, depends on the firm's expected cost level in that period. Both the magnitude and precision of the firm's expected cost level change as the firm ages and gathers additional evidence about its production efficiency. Firms which learn they are relatively efficient will expand while firms which learn they are inefficient will contract.[9] As a result, the post-entry size of a new firm depends on the firm's age. The model also predicts that the failure rate of a cohort of entrants will vary as the firms age. As an entrant ages, each additional observation on its production cost leads to smaller revisions in its expected efficiency level and expected future profits. The probability that a new cost observation causes a firm's expected profit level to decrease enough so that exit is preferred over continuing in operation will thus diminish as the firm ages. Cohort failure rates should therefore decline with age.[10]

Finally, the selection model suggests that systematic differences in the characteristics of entrants will lead to differences in performance. Suppose that entrants are characterized by differing values of entry costs, fixed costs, or differing expectations of variable costs. Potential entrants with relatively low entry, fixed, or variable costs will be more likely to enter. Firms with relatively high fixed costs will be more likely to exit. An entrant with a relatively high expected efficiency level will enter at a larger size. An entrant or firm with a relatively precise expectation of its efficiency will experience relatively small changes in size.

Diversifying firms, for example, may have both lower entry costs and more precise estimates of their expected cost in the new industry because of their operating experience in other industries. They may also have lower expected

variable cost levels than new firms because of favorable cost information derived from production in existing industries. Among diversifying firms, those entering by varying the mix of products produced in their existing plants may have particularly low entry costs. The lower expected variable costs of diversifying firms cause them to enter at a larger size and their relatively precise cost expectations make them less likely to fail. These considerations lead us to classify entrants according to whether they are new or diversifying firms, single or multi-plant firms, and whether they enter by opening new plants or altering the mix of products produced in a given plant.

We thus have industry growth rates, the firm's age, and the firm's entry category as factors which may affect entry and post-entry performance. The next section explains how these, together with time and industry effects, are integrated into an empirical analysis.

III. Data and Measurement

1) Data

This paper will examine the pattern of firm turnover in 26 four-digit chemical industries, SIC 2812 through 2893, over the 1963-1982 period.[11] Data for the firms producing in each of these chemical industries are constructed from the individual plant-level observations collected in the last five Census of Manufactures. These cover the years 1963, 1967, 1972, 1977, and 1982. The plants in each census have recently been matched across census years to form a panel data set of all plants in the manufacturing sector.[12]

Construction of this data begins with the time-series observations on the individual chemical manufacturing plants. For each plant in the manufacturing sector the Census Bureau collects the value of shipments of each seven-digit product manufactured in the plant. We aggregate each plant's value-of-

shipments data to the four-digit level. Rather than classifying each plant into a single four-digit industry based on the plant's primary product, however, we treat each plant as operating in all four-digit industries in which it products output.[13] Each firm's value of shipments for each four-digit industry is then constructed by aggregating over all manufacturing plants owned by the firm. Throughout the remainder of this paper we use the term firm to refer to a producer in a four-digit industry. Multiproduct producers are counted as a firm in each industry in which they have output shipments.

This data construction process has three important advantages for the study of entry and exit. First, by using data on each firm's output level, it is possible to measure the size as well as number of entrants and hence compute their market share. Second, it recognizes that firms are frequently multiproduct producers and that existing firms can become entrants into a new industry by either opening new plants or by altering the mix of outputs they produce in their existing plants. Third because of the longitudinal nature of the data set, it is possible to track an entrant's post-entry growth and failure.[14]

Four characteristics of each entrant in each chemical industry are constructed. The first is the year of entry. This is the year of the census in which the firm first appears in the industry.[15] This is equivalent to classifying firms into entry cohorts and will be useful in examining the post-entry performance of the entrants as they age. The second characteristic is the value of output produced by the firm in the industry. The third is the entrant's type. We distinguish entrants as one of four types: new single-plant firms, new multi-plant firms, diversifying single-plant firms, and diversifying multi-plant firms. Firms are classified as diversifying firm

entrants when they were present as producers in a different four-digit manufacturing industry in the previous census year. Firms are new firm entrants when they were not present in any manufacturing industry in the previous census. The distinction is made between single and multi-plant firms because of significant differences in size between these firms in the chemical industries.[16] The final characteristic of entrants which is distinguished is the method of entry. This classifies firms by whether they entered the industry through the construction of a new plant or whether they altered the mix of products produced in their existing plants.[17]

Not every combination of the four entry types and two entry methods can occur. New firms cannot enter by altering the mix of products produced in existing plants because they have no previously existing plants. Single-plant diversifying firms cannot enter an industry by opening a new plant because they would then be classified as multi-plant firms. Altogether there are five possible combinations of entry type and method, summarized in Table 1. The initials used in the table will be used to classify the entrants in the remainder of the paper.

Table 1

Possible Combinations of Entrant Method and Type

	Entry Method	
Entrant Type	New Plant Construction	Change in Product Mix
New Single-Plant Firm	New/SP	*
New Multi-Plant Firm	New/MP	*
Diversifying Single-Plant Firm	*	Div/SP
Diversifying Multi-Plant Firm	Div/MP/NP	Div/MP/PM

*Entrant type and method combination cannot occur.

In this data, the first group of entrants in each industry is observed in 1967. These are firms which entered the industry between 1964 and 1967. These same firms are observed and their size, or value of their output, is measured in each subsequent census year 1972, 1977, and 1982 if they remain in the industry. In addition to allowing the 1967 entrants to be observed over time, the data contains information on the new entrants to each industry in each succeeding census year 1972, 1977, and 1982. Each of these entering cohorts can then be observed in census years following entry.

Because of the five-year intervals between censuses, the first time a group of entrants is observed the firms are actually between zero and four years of age. In the next three censuses these firms are five to nine, ten to fourteen, and fifteen to nineteen years of age, respectively.[18] In the empirical work age will always be treated as a qualitative variable measuring the number of censuses in which the firm has been observed in the industry.

The data also contains observations on all producers present in the chemical industries in the census year 1963. It is not possible to observe how these firms entered the industry and hence we cannot disaggregate these firms by their type or method of entry although we can separate the firms into single-plant and multi-plant producers. These firms also cannot be classified into age categories comparable to the categories used for later entrants because the date of the earliest census in which they appear is unknown. We can observe their growth and failures rates across subsequent censuses but cannot directly compare these aging patterns to the age results for later cohorts because we are unable to control for the mix of ages of all producers present in 1963.

Overall, the data set contains observations from five years on all nonfailing firms present in the 1963 census, four observations on firms which

enter in the 1967 census, three observations on the 1972 entrants, two observations on the 1977 entrants, and the initial entry year information for the 1982 entrants. Failure rates and characteristics of the firms which exit from each of these entry cohorts can also be observed in each census year.

There are several advantages of using Census of Manufactures data to examine entry and exit patterns. The census provides complete coverage of all producers, regardless of size, in all four-digit manufacturing industries. The twenty-year period available for study is long enough that a complete cycle of entry, growth, and exit can be observed for a large number of firms. The multiple observations over the period also allow an industry to be observed in expansionary, stable, and contractionary periods. The availability of output data on each of a plant's multiple products is extremely valuable in examining both the relative sizes of entrant and incumbent firms and the importance of entry through changes in an incumbent firm's product mix. Finally, to a large extent, it is possible to separate firm entry from ownership changes or conglomerate mergers. These latter two changes result in a change in the name of the firm owning the production facilities but no change in the number or size distribution of competitors in the industry. In this study ownership changes are not classified as the exit of an existing producer and the entry of a new producer.

The census data do impose some limitations on the questions which can be addressed. The manufacturing census is only taken at five-year intervals and it is accordingly not possible to identify firms that enter and exit between adjoining census years. Estimates of entry and exit rates constructed from quinquennial census data will underestimate the year-to-year turnover.[19] A second limitation is that it is not possible to identify the entry year or method of entry for firms that appear in the 1963 census. Patterns for these

firms will be summarized separately in the empirical results reported in this paper. A third limitation is the possibility of error in the matching of small plants across census years. This occurs because a change in the ownership of a small plant, particularly those owned by single-plant firms, can lead to a change in the plant's identification numbers which are used to identify and track the plant over time. This measurement error will bias the entry and exit rates upward but, because of the relatively small size of these plants, will have much less effect on the market shares of entering or exiting firms.[20] Finally, extremely small plants are treated differently in the data collection process.[21] Each of these small plants is treated as a single-product producer. The Census Bureau has increased the number of plants in this category in each census year since 1967. This administrative change could result in a slight increase in exit rates although, because of the small size of the plants involved, there will be no significant effect on the market share of exiting firms.

2) Measurement of Entry Variables

The majority of the empirical work in this paper will summarize the importance of entrants, relative to all firms in the industry, at a point in time. In order to make this discussion more precise we define the following variables:

$NE_j(i,t)$ = the number of firms in entrant category j which enter industry i between census years t-1 and t.

$N(i,t)$ = total number of firms in industry i in census year t.

(1)

$QE_j(i,t)$ = total period t output of firms in entrant category j which enter industry i between census years t-1 and t.

$Q(i,t)$ = total output of industry i in census year t.

The three variables which will be used to summarize the importance of an entering group of firms are the share of the number of firms in the industry, the market share, and the average size of entering firms relative to the average size of all firms in the industry. The share of the number of firms in industry i in year t which belong to entrant category j is measured as

$$(2) \qquad SN_j(i,t) = NE_j(i,t)/N(i,t).$$

The market share of the entrants in category j in industry i in year t is measured as

$$(3) \qquad SQ_j(i,t) = QE_j(i,t) \; / \; Q(i,t).$$

The average size of a group of entrants in category j relative to the average size of all firms in the industry is measured as

$$(4) \qquad RSE_j(i,t) = ASE_j(i,t)/AS(i,t) \text{ where}$$

$$ASE_j(i,t) = QE_j(i,t) \; / \; NE_j(i,t)$$

$$AS(i,t) = Q(i,t) \; / \; N(i,t).$$

This last variable will be referred to as the relative average size of entering firms.

These entry measures will be analyzed in three sections. First, the short-run impact of entrants on market structure will be examined by studying the incidence of entry, the relative average size, the market share of entrants, and the degree of heterogeneity among entering firms in their initial entry year. Second, the longer-term effect of entrants on industry structure will be addressed by examining how the number, relative average size, and market share of an entering cohort of firms change over time. The

third section examines the forces behind the changing importance of an entering cohort by examining the rates and sizes of surviving and failing firms within a cohort.

IV. The Incidence of Entry

This section provides information on the three characteristics of entering firms in their initial year of observation: market share, their average size relative to the average size of all firms in the industry, and their share of the total number of firms in the industry. These three variables are linked by the identity:

$$(5) \qquad SQ_j(i,t) = RSE_j(i,t) \cdot SN_j(i,t).$$

This equation will be useful for disaggregating the output share of an entering cohort into relative size and numbers components.

In order to summarize the average characteristics of entering firms across the twenty-six industries and four time periods we estimate the following empirical model:

$$(6) \qquad Y_{it} = \beta_0 + \sum_{i=1}^{25} \beta_i D_i + \sum_{t=1}^{3} \gamma_t D_t + \alpha_1 G_{it} + \alpha_2 G_{it}^2 + \varepsilon_{it}$$

where β_0 is an intercept; D_i is a dummy variable equal to 1 for industry i and zero otherwise; D_t is a dummy variable equalling 1 for time period t and zero otherwise; G_{it} measures the average annual rate of growth of real output for industry i between census years t-1 and t and G_{it}^2 is the square of the industry growth rate.[22] Y_{it} is an observation on one of the entry variables (market share, relative average size, or share of the number of firms) for firms entering industry i between census years t-1 and t. A random

disturbance term ε_{it} is also included in the model specification.

The empirical model is designed to provide summary statistics of the entry process in the four-digit chemical industries over the 1967-1982 period. The model is not designed to provide a structural explanation of industry evolution. The goal is to summarize differences in the incidence of entry after controlling for time-invariant industry differences, time-period differences which affect all industries, and time-varying industry factors. The industry dummy variables are included to control for time-invariant industry effects. These include many aspects of the technology, demand conditions, or degree of industry competition which are relatively constant over time. The time dummies control for factors which are common to the manufacturing sector at a point in time. These could include credit availability, tax effects, or macroeconomic influences. The rate of industry growth and growth squared are included to control for time-varying industry factors, particularly the demand for each industry's output over time.

The empirical model in equation (6) is estimated separately, using ordinary least squares, for each of the three entry variables and each of the five categories of entrants. For comparison, the model is also estimated for the total group of entrants, not disaggregated by type and method of entry, and the incumbent firms present in each year. The separate regression results are reported in the appendix in tables A1, A2, and A3.

In order to succinctly summarize the regression results we first calculate the fitted value of equation (6) for industry i in year t as

$$(7) \qquad \hat{Y}_{it} = \hat{\beta}_0 + \hat{\beta}_i + \hat{\gamma}_t + \hat{\alpha}_1 \bar{G} + \hat{\alpha}_2 \overline{G^2}.$$

The fitted value $\hat{Y}_{it}$ is calculated at the sample mean values of the industry growth rate and growth rate squared. The average value of equation (7) is

then constructed by averaging the $\hat{Y}_{it}$ over the 104 industry-year observations in the sample. These industry-year averages, together with their estimated standard errors, are reported in Table 2.

The first column of Table 2 reports the average output share for incumbent firms, for all entrants, and for each of the five categories of entrants. The results reported in the first two rows of Table 2 reveal that, on average across the 26 four-digit industries and four years, incumbent firms accounted for 90.7 percent of industry output while entrants accounted for 9.3 percent. The second and third columns of Table 2 disaggregate each group's market share, using equation 5, into the relative average size of firms in the group and the group's share of the number of firms in the industry. The table shows that incumbents account for 55.8 percent of the number of firms in the industry and that their average size is 1.676 times larger than the average size of all firms. In contrast, entrants account for 44.2 percent of the number of firms in the industry but the average size of an entrant is only .217 times the average size of all firms and only .129 times the average size of the incumbents. Entrants are thus small relative to the incumbents and the entrants' share of industry output is substantially less than their share of the number of firms.

The remainder of Table 2 disaggregates entrants into the five entry categories. The output share of the five categories varies from a low of .9 percent for diversifying single-plant firms to a high of 2.5 percent for diversifying multi-plant firms which enter by building new plants. This fairly modest difference in market shares, however, is generated by more substantial offsetting variations in the relative average size and number of firms in each category of entrants.

The relative average sizes of entering firms differ significantly across

categories, particularly between single-plant and multi-plant firms. Single-plant firms, both new and diversifying, have output levels which are, on average, 10 percent of the average level of all firms. In contrast, multi-plant firms which enter a new industry do so at an average size between 39.8 and 78.2 percent of the average size of all firms. That is, multi-plant entrants are, on average, between four and eight times larger than single-plant entrants, even though the average entrant in both groups is still smaller than the average incumbent. Within the group of multi-plant firm entrants, diversifying entrants tend to enter at a larger average size than new firm entrants. Finally, among the multi-plant diversifying entrants, those who enter by opening a new plant are approximately 46 percent larger than those who enter by altering the mix of outputs produced in their existing plants.

In general Table 2 reveals that the numbers of entrants and their relative average sizes are inversely related across entrant categories. For example, the smallest entrants, single-plant firms, are the most numerous, together accounting for approximately 30 percent of an industry's firms and over three-quarters of the number of entrants. The larger entrants which are multi-plant firms, account for only 15 percent of an industry's firms and 25 percent of an industry's entrants.

V. Post-Entry Performance of Entry Cohorts

The long-term impact of an entering cohort of firms can be assessed by examining their output share and relative average size in the years following their entry. This longitudinal analysis allows us to distinguish cases in which firms enter and subsequently grow to achieve a substantial market share from cases in which entry is followed by contraction or rapid exit.

To examine these aging patterns, the output share, relative average size, and share of the number of firms in the industry, are constructed for each entrant group in the census year of entry and in each census year following entry. The regression model in equation (6) is then extended to control for possible aging effects. A set of categorical age variables is added so that the regression equation used in this section becomes

$$(8) \qquad Y_{it} = \beta_0 + \sum_{i=1}^{25} \beta_i D_i + \sum_{t=1}^{3} \gamma_t D_t + \alpha_1 G_{it} + \alpha_2 G_{it}^2 + \sum_{i=1}^{3} \delta_i A_i + \varepsilon_{it}.$$

The three age variables are defined to take the value one in either the second, third, or fourth census year in which the entrant cohort is observed. The base category is the initial entry year. All other variables are the same as defined in equation (6). After estimation of equation (8), the average of the industry-year fitted values, for an entry cohort in their initial year of observation, is constructed as described in the previous section. The coefficients on the categorical age variables are then used to summarize how the characteristics of the entering cohort change as they age.

The complete set of regression results for each of the three summary variables and entrant categories are reported in appendix tables A4, A5, and A6. The average fitted values across industries and years are summarized in Table 3. The first column summarizes the variables in the initial entry year and the remaining columns measure the change from the initial entry year as the firms age. Also included in the summary are the corresponding figures for the firms present in each industry in the 1963 census. These firms are disaggregated into single and multi-plant producers.[23]

The top third of Table 3 reports data on output shares. A strong pattern appears. The values of the age effects for ages five through nineteen are

negative, indicating that each group of firms loses market share as it ages. On average, entering firms account for 9.3 percent of industry output in their initial census. Their market share declines as they age and they account for approximately 5.1 percent of industry output when they are between 15 and 19 years old.

The decline in market share as the entrants age is heavily concentrated among the single-plant firms. Both new and diversifying single-plant firms lose virtually all of their market share over a twenty-year period. In contrast, the loss of market share for multi-plant firm entrants is modest in magnitude, particularly for the diversifying firms, and the decline with age is not statistically significant. Overall, the long-run contribution of a single cohort of entrants to the output of the chemical industries is thus fairly small and highly concentrated among firms which were multi-plant producers that diversified from other industries. When it is recognized that these multi-plant diversifying entrants include firms producing in other four-digit chemical industries, it suggests that the long-run contribution of new, non-chemical manufacturing firms to production in the chemical industries is very small.

While any one cohort of entrants may have a small long-run impact on industry structure, the cumulative effect of multiple entry cohorts will be more substantial. This can be seen by examining the decline in market share for the 1963 firms over time. In the base year (1967) the single-plant firms had an average market share of .076 in the 26 chemical industries. This share declined by .040, .051, and .063 across the next three census years. By 1982 the average market share of single-plant firms which were present in the 1963 census had fallen to .013 (= .076 - .063). However, the market share of the multi-plant producers from the 1963 census declined at a much lower rate. On

average, the market share of these firms was .842 in 1967 and declined to .703 (= .842 - .139) by 1982. The multi-plant firms which were in operation in an industry in 1963 were thus still responsible on average, for 70 percent of the output of that industry in 1982. The 30 percentage point decline in their market share is the cumulative effect of the four entry cohorts.

Though the market shares of entrants decline after entry, some entrants may grow and become substantial contributors to industry production. In order to examine this possibility equation (5) is used to disaggregate a cohort's market share in each year into the relative average size of the remaining members of the cohort and their share of the number of firms in the industry. The last two sections of Table 3 report the average size of the remaining members of the cohort, relative to the average size of all firms in the industry, and the cohort's share of the number of firms in the industry. The first column contains the estimates for the cohort's entry year and the remaining columns report changes from the entry year.

The results in Table 3 for all entrants indicate that the average size of these firms increases from 20.9 percent of the size of all firms at the time of entry to 116 percent when the firms are at least fifteen years of age. This indicates that after fifteen years the average size of a cohort's surviving firms is approximately equal to the average size of all firms in the industry.[24]

When the entrants are disaggregated by type of firm and method of entry the heterogeneity across entrant categories is seen to be particularly important. On average, single-plant firms which enter the chemical industries begin at approximately 10 percent of the average size of all firms and never increase to more than 20 percent of the average size of all firms over a fifteen-year period. In contrast, multi-plant diversifying-firm entrants have

an average size which exceeds the industry average after five years and is between two and three times greater than the industry average after fifteen years. The average size of new multi-plant entrants also increases substantially though they remain smaller than the diversifying-firm entrants at every age. Overall, the pattern is one in which the surviving single-plant entrants remain smaller than average while surviving multi-plant entrants, particularly those diversifying from other industries, have an average size which exceeds the industry average by the time they are five to nine years old.[25]

The results on the relative average size of 1963 firms again reveal that single and multi-plant firms are strikingly different. For the 1963 firms, the single-plant producers have no significant increase in average size over time. In 1967 these firms are approximately 20 percent of the size of the average firms in the industry. This increases to 29 percent by 1982 but the increase is not statistically significant. In contrast, the average multi-plant firm from 1963 is 3.35 times larger than the average firm in 1967 and this increases to 5.67 times by 1982.

The final piece of information needed to explain the decline in a cohort's market share over time is the change in the proportion of the industry's producers which belong to the cohort. Because the average size of the surviving members of the cohort rises, while its market share declines, the share of the industry's firms which belong to the cohort must decline with age. This decline in the cohort's share of the number of firms in the industry is revealed in the bottom portion of Table 3. The share of the number of firms in the industry belonging to any group, 1963 firms or any category of later entrants, declines substantially with age.[26] In particular, the cohort of all entering firms declines from 45.7 percent of the total

number of firms in the industry in its initial year to only 2.8 percent after fifteen years. This decline is much larger than the decline in an entering cohort's market share reported above. Also noticeable is the decline of both the single and multi-plant new firm entrants. The only entrant group which does not lose virtually all of its members is diversifying-firm entrants which enter by opening new plants.

The patterns revealed in Table 3 indicate that an entering group of firms makes its largest contribution to industry output in the period of entry. As a cohort ages, the average size of the surviving members of the cohort rises relative to the average size of all firms in the industry. This increase in average size is outweighed by a decline in numbers of firms so that the cohort's market share falls. There is, however, considerable heterogeneity across entrant categories in the magnitude of these effects.

VI. Growth Versus Failure Within a Cohort

The previous section indicates that the average size of the surviving members of a cohort increases in the years following entry. This finding alone reveals nothing about whether the individual firms in the cohort grow. Even if the surviving members of a cohort experienced no change in size as they aged, this pattern could arise if failures were concentrated among the cohort's smallest firms. Alternatively, it may be that failures are evenly dispersed across firms of all sizes but that continuing firms grow.

In this section we examine these two factors that potentially contribute to the change in the average size of the surviving members of a cohort; one resulting from the growth of surviving firms and the other from the exit of small firms. To do this, we must look within a cohort to compare the sizes of surviving and failing firms. This contrasts with the framework of

the last two sections in which comparisons were made between the cohort and the rest of the industry.

We begin by writing the average size of all members of an entry cohort in industry i at time t as a weighted sum of the average size of the cohort members who will survive until time t+1 and the average size of the cohort members who will fail before t+1:

$$(9) \qquad \frac{QE_j(i,t)}{NE_j(i,t)} = \left(\frac{QE_j^c(i,t)}{NE_j^c(i,t)}\right)\left(\frac{NE_j^c(i,t)}{NE_j(i,t)}\right) + \left(\frac{QE_j^x(i,t)}{NE_j^x(i,t)}\right)\left(\frac{NE_j^x(i,t)}{NE_j(i,t)}\right).$$

The superscripts c and x denote firms that will continue until period t+1 and those that will exit. $QE_j^c(i,t)/NE_j^c(i,t)$ is the average size, in period t, of all members of the cohort who will survive until period t+1. $NE_j^c(i,t)/NE_j(i,t)$ is the continuation rate, or proportion of period t cohort members who will survivie until t+1. $QE_j^x(i,t)/NE_j^x(i,t)$ is the average size, in period t, of all cohort members who will not survive until period t+1. $NE_j^x(i,t)/NE_j(i,t)$ is the cohort's failure rate. The <u>change</u> in the average size of the cohort's members between period t and t+1 can then be written as

$$(10) \qquad \frac{QE_j(i,t+1)}{NE_j(i,t+1)} - \frac{QE_j(i,t)}{NE_j(i,t)} =$$

$$\left(\frac{QE_j^c(i,t+1) - QE_j^c(i,t)}{NE_j^c(t)}\right) + \left(\frac{QE_j^c(i,t)}{NE_j^c(i,t)} - \frac{QE_j^x(i,t)}{NE_j^x(i,t)}\right)\left(\frac{NE_j^x(i,t)}{NE_j(i,t)}\right)$$

The derivation of this equation makes use of the facts that the number of firms in the cohort which continue from period t to t+1, $NE_j^c(i,t)$, equals the total number of firms in the cohort in t+1, $NE_j(i,t+1)$ and that the continuation rate equals 1 minus the failure rate.

The right side of equation (10) consists of three terms. The first term

is the change in the average size of the cohort members which are present in both time periods. If, on average, the surviving members of the cohort expand (contract) over time then this term will be positive (negative) and act to increase (decrease) the average size of the cohort. The second term is the difference in the period t average size between the firms that will continue and exit in period t+1. This difference is multiplied by the third term, the cohort failure rate. If the failure rate equals zero then the only factor which contributes to the change in the average size of the cohort is the change in the average size of the surviving members. If the failure rate is nonzero, as is generally the case, then the average size of the cohort will also be affected by whether the failing firms are, on average, larger or smaller than the continuing firms. If the failing firms are smaller than the continuing firms, for example, then the presence of failure acts to increase the average size of the cohort.

In order to assess the relative importance of these two forces we estimate the following regression model:

$$(11) \qquad Y_{it} = \beta_0 + \sum_{i=1}^{25} \beta_i D_i + \sum_{t=1}^{2} \gamma_t D_t + \alpha_1 G_{it} + \alpha_2 G_{it}^2 + \sum_{i=1}^{2} \theta_i A_{it} + \varepsilon_{it}$$

We estimate (11) with the dependent variable Y_{it} representing each of the three terms on the right side of (10). When examining the change in the average size of the surviving firms and the difference in the average size of the surviving and failing firms, both measures will be divided by the average size of all firms in the industry. This scaling both removes large size differences across industries and controls for any changes in the average size of all firms in the industry over time. A regression equation for each of the three variables in equation (11) is estimated for the 1963 single-plant firms,

1963 multi-plant firms, and each of the five categories of entrants. Notice that there are now only two time and age variables which are used to distinguish three time and age categories. This arises because we are now examining changes between census years, and the four years (1967, 1972, 1977, 1982) over which entrants are observed and followed yield three time and age intervals.

After estimation the averages of the industry-time fitted values are constructed as described in the previous two sections. The coefficients on the categorical age variables are again used to summarize how each of the three terms in equation (10) vary as the cohort ages. The results of the separate regressions are reported in tables A7, A8 and A9 in the appendix and the key information from those regressions is combined in Table 4.[27] The first column of Table 4 reports the average industry-time effects for the entrants' first five year period of observation, that is the period between a cohort's initial census and the next census year of observation. The second and third columns report the changes from this base as the cohort ages.

The top part of Table 4 reports the change in the average size of continuing firms relative to all firms in the industry. Among the entering firms, both the new and diversifying single-plant entrants which survive expand following entry. This expansion for the new and diversifying single-plant entrants equals approximately 4.6 percent and 3.8 percent, respectively, of the output of the average size firm in the industry. Because of their small initial size, these expressions, however, do represent significant growth rates, on the order of 40 percent, for these firms. The major post-entry expansion comes from diversifying multi-plant firms which entered the industry by building new plants. In their first five years they expand by an amount equal to 58.8 percent of the output of the average size

producer in the industry. The remaining entrant types, new multi-plant firms and diversifying product-mix entrants, have positive increases in size but the average increases are not statistically significant.

For the 1963 firms there is no significant change in size for single-plant firms but a significant positive change for multi-plant firms. On average, the expansion in the size of the surviving multi-plant firms equals 53.3 percent of the size of the average firm in the industry. Alternatively, the increase in the size of one of the continuing 1963 multi-plant firms equals the size of approximately five new single-plant entrants. Finally, there is no significant change in these patterns as the cohort ages. The overall conclusion from these numbers is that surviving firms do grow and the change in their average size contributes to the overall increase in the average size of the cohort members.

The second part of Table 4 reports the difference between the average size of a cohort's continuing and exiting firms, as a proportion of the average size of all firms in the industry. Over the first five years of operation there is a positive, significant difference for four of the five categories of entrants. The positive coefficients in column 1 indicate that the continuing firms, on average, are larger than the failing members of their cohort. This indicates that failure is more heavily concentrated among the smaller members of the cohort. Firm attrition will thus tend to raise the average size of the cohort members over time. Furthermore, the difference in size between continuing and failing firms varies systematically with age. For all multi-plant producers, those present in the 1963 census as well as later entrants, the difference in size between continuing and failing plants increases with age. This aging pattern does not appear for the single-plant producers.

Comparing the magnitudes of the coefficients in the second part of Table 2 indicates that the difference in the average size of continuing and failing firms is most extreme for multi-plant firms. For example, a cohort of diversifying multi-plant, product mix entrants has an average size for continuing firms which exceeds the average size of failing firms by 55.1 percent of the average size firm in the industry. This difference increases to 1.71 (= .555 + 1.16) times the average size firm in the industry when the cohort members are fifteen years old. Because of their smaller initial size, the size difference between continuing and failing single-plant firms is less extreme. These results imply that firm failure will result in an increase in the average size of the surviving members of a cohort and this increase will be most pronounced for multi-plant firms.

The final section of Table 4 reports the pattern of failure rates for the two groups of 1963 producers and the five categories of entrants. All categories have failure rates which are positive and which tend to decline with age, although the rate of failure varies with the type of firm. Among the entrants, single-plant producers have the highest initial failure rates, followed by the new multi-plant producers, and finally the diversifying multi-plant producers. In addition to having the highest failure rates, the single-plant entrants also have the lowest absolute decrease in their failure rates as they age. Single plant firms from the 1963 census have a failure rate over the first five-year interval of .500, slightly more than twice the rate of their multi-plant counterparts.

The results of Table 4 indicate that both the growth of surviving firms and the failure of relatively small producers contribute to the increase in the average size of the surviving members of an entering cohort. As the firms age there is no significant effect on the change in the average size of the

continuing firms. There is, however, a further widening of the difference in the average size of the surviving and failing firms with age but the importance of this effect is partially offset by the reduction in the rate of firm failure.

VII. Conclusions

The findings reported in this paper suggest four implications. First, the long-run impact of a cohort of entrants on market structure in the chemical industries is very small. While, on average, forty-five percent of the firms in each industry in each census year are new entrants, their small average size, high failure rates, and overall decline in each cohort's market share combine to reduce their long-term contribution to industry output. Combined with the finding that the entering firms which are most likely to survive and grow are firms which are diversifying from other industries, including other four-digit chemical industries, this suggests that the long-term impact of new firm entry on the structure of these industries is probably trivial.

While the contribution of each cohort is small, the combined effect of multiple entry cohorts over time does have some effect. For example, on average across the industries, the firms which were in operation in the industry in 1963 were responsible for seventy percent of industry output in 1982. Twenty years of entrants account for thirty percent of 1982 industry output. Of course, entrants may not have to significantly alter industry structure in order to have an impact on the degree of competition in the industry. However, these findings do suggest that any assessment of industry performance cannot stop with evidence that there are large numbers of entrants.

Second, entrants appear to fare less well in the chemical industries than in the average manufacturing industry. For example, Dunne, Roberts, and Samuelson (1988b) find that, on average across all manufacturing industries, 58 percent of industry output in 1982 is produced by firms which were present in the industry in 1963. Twenty years of entrants are here able to account, on average, for 42 percent of a manufacturing industry's output. This difference appears to be driven primarily by more dramatic increases in the average size of surviving firms in manufacturing as a whole than in the chemical industries. A surviving 15 to 19 year-old entrant in the chemical industries is on average the same size as the average size firm in the industry. On average, across all manufacturing industries the 15 to 19 year-old entrant would be approximately 20 percent larger than the average size firm in the industry.

Third, it is interesting to note that, despite the common association between industry growth and entry in other studies, the relatively high growth rates of the chemical industries do not have an appreciable impact on entry in these industries. As revealed by the regression coefficients reported in the appendix, the only significant effects of industry growth occur on the number and market share of new multi-plant firms.

Finally, the results indicate that the performance of new producers varies significantly with the type and method of entry. Single-plant firms are the most numerous entrants but also the smallest. Their initial market share is less than half that of multi-plant entrants and rapidly declines. Multi-plant firms are not only initially larger but experience a much less pronounced decline in market share. This is especially true of multi-plant firms entering by diversifying from other industries. These entrants grow, on average, to between two and three times the average size of all firms in the

industry within fifteen years. This suggests that the impact of entrants on market structure may vary significantly with the type of entrants attracted to the industry. An assessment of the performance implications of entry must recognize this heterogeneity.

Footnotes

[1]Entrants need not be large to have an effect on the competitiveness of a market. For example, the widely-used dominant-firm model emphasizes the constraints on market power provided by the supply response of a competitive fringe of firms. In their theory of contestable markets, Baumol, Panzar and Willig (1982) have argued that competitive outcomes will be the norm in markets which are characterized by an absence of sunk costs and the ability of new competitors to enter more rapidly than incumbent firms can respond. In this case competitive outcomes do not require entrants to be large or long-lived and do not even require entry to occur. However, strategic considerations such as first-mover advantages, the presence of sunk costs, imperfect information about market demand or own or rival firm costs, financing constraints, or heterogeneous production costs can limit the competitive impact of entry in general and small scale entry in particular.

[2]Patterns of gross exit using cross-sectional industry data have been reported by MacDonald (1986), Baldwin and Gorecki (1987a) and Shapiro and Khemani (1987). While examining the structural characteristics of industries which are correlated with exit, these papers do not study the aging patterns which are important for understanding the long-run contribution of an entering firm or cohort.

[3]Much of this literature focuses on the growth of existing firms and attempts to ascertain whether firm growth rates are independent of firm size. This literature is summarized in Evans (1987b).

[4]Several other studies have recognized the importance of distinguishing different entrant types. Gorecki (1975), Hause and DuRietz (1984), MacDonald (1986), and Schwalbach (1987) distinguish between new and diversifying firm entrants. Caves and Porter (1977) examine the justification for this dichotomy. Baldwin and Gorecki (1987a) distinguish firms which enter through new plant constuction from those which purchase existing facilities. Dunne, Roberts, and Samuelson (1988b) distinguish new firm entrants from two types of diversifying entrants, firms which build new plants and firms which alter the mix of outputs produced in their existing plants. Lieberman (1987a, 1987b) studies the post-entry expansion of incumbent firms according to whether they construct new plants or expand the output of existing plants. Geroski and Masson (1987) and Schmalensee (forthcoming) survey the empirical evidence on industry entry and exit patterns.

[5]Hause and DuRietz (1984), Baldwin and Gorecki (1987a), MacDonald (1986), Schwalbach (1987), and Highfield and Smiley (1987) have all found output growth to be highly correlated with entry.

[6]The sources of these random disturbances could include fluctuations in the prices, quality, and availability of inputs; turnover in the labor force and fluctuations in labor supply; mechanical difficulties with equipment and machinery; and coordination problems.

[7]This is a highly stylized model designed to focus attention on the entry and exit implications of cost heterogeneity and firm learning. Two additional factors which have potentially important effects on entry and exit

decisions, particularly in the chemical industries, are adjustment costs and learning-by-doing.

[8]Lieberman (1987b) finds that entry sizes in the chemical industries are relatively insensitive to industry growth rates.

[9]Evans (1987a, 1987b) and Dunne, Roberts, and Samuelson (1988a) examine the implications of Jovanovic's selection model for firm growth rates in much greater detail.

[10]Evans (1987a, 1987b), Dunne, Roberts, and Samuelson (1988a), and Pakes and Ericson (1988) find that failure rates vary with firm age. The theoretical link between age and failure probability is complex and its direction is ambiguous. A firm will exit after period t if its period t cost observation causes the expected value of its cost parameter c to rise above a failure boundary. Given a fixed failure boundary, the probability that an additional cost observation will push the firm's expectation above the failure boundary decreases as the firm ages, because the firm's cost expectation becomes more precise and is less affected by additional observations. At the same time, the failure boundary may decrease with age. A young firm may tolerate a high, imprecise cost expectation without failing in hopes of discovering it is actually a low-cost producer. An older firm may be unwilling to remain in the industry in the presence of a high, very precise cost expectation. We then have conflicting forces and an ambiguous net effect. Pakes and Ericson (1988) have emphasized the inability to sign this effect without further assumptions, presumably on functional forms. The empirical studies cited above find that failure probabilities decrease with age.

[11]Two chemical industries, carbon black (SIC 2895) and chemical preparations not elsewhere classified (SIC 2899) are deleted from the analysis. SIC 2895 has fewer than ten firms in the industry and virtually no entry or exit over the period. SIC 2899 is often used as a residual category when it is difficult to assign outputs to one of the other industries and thus often includes a very heterogeneous mix of products. The not-elsewhere-classified industries tend to have higher than average rates of turnover. The chemical industry has been examined in studies by Lieberman (1984, 1987a-d) and Gilbert and Lieberman (1987) with Lieberman (1987b, 1987d) particularly focusing on entry issues. His data generally covers a more narrowly defined but much more disaggregated set of products than the four-digit industry-level data analyzed in this paper.

[12]See Dunne and Roberts (1986) or Dunne, Roberts, and Samuelson (1988b) for details of the construction of the plant-level panel data set.

[13]When constructing the published industry totals for the Census of Manufactures, the Census Bureau assigns all of a plant's data to the four-digit industry which accounts for the largest proportion of the value of the plant's shipments. For the study of firm entry it is desirable to recognize that a plant can produce multiple outputs, and thus a firm can operate in multiple industries even if it only owns a single plant. Because of multi-product production it is possible for firms to enter new industries by altering the mix of products they manufacture in their existing plants.

[14]The entry studies cited above generally use data from just two points in time. This allows the measurement of one group of entrants and one group of exits but does not allow entering firms or cohorts to be observed after entry.

[15]A firm which exits an industry, that is, has no output in that industry in a census year, and then reenters the same industry in a later census year is classified as an exiting firm when it leaves and as an entrant in the year it reenters.

[16]Firms which switch from single to multi-plant status are classified as multi-plant firms throughout the entire time period. Changes in ownership status are uncommon in the census data. Dunne and Roberts (1986) report that of the 819,631 different plants present across the last five censuses, 83.16 percent were always owned by single-plant firms, 16.03 percent were always owned by multi-plant firms and only .85 percent (6891 plants) changed ownership status.

[17]The term "new plant construction" is used to refer to both newly-built plants as well as previously-existing plants which have just been brought into production in this industry. For example, a firm which enters an industry by renting or purchasing an existing building and setting up a manufacturing operation in the facility would be classified as entering through new plant construction. In the dataset we have also distinguished firms which enter an industry through the purchase of an existing facility from an existing producer. In order to be classified as an entrant, we require that the selling firm remain in the industry. If the selling firm exits the industry the transaction is classified as an ownership change and is not treated as the exit of an existing firms and the entry of a new firm. The number of firms which fall into this entry category is small, their entry rate is less than .5 percent in all manufacturing industries and they never account for more than 1.2 percent of any industry's output in any year. Because of their small numbers, these entrants have been aggregated with the firms which enter through new plant construction.

[18]Because only four years elapse between the 1963 and 1967 census the comparable ages for 1967 entrants in each census year are zero to three, four to eight, nine to thirteen, and fourteen to eighteen. To simplify the discussion we will refer to these entrants using the same age categories as later entrants.

[19]The Annual Survey of Manufactures which is collected in each of the non-census years, is not useful for correcting this problem. It is weighted toward larger plants and plants owned by multi-plant firms and thus is not representative of the population of entrants. In addition, the ASM does not collect output data at the seven-digit level and this prevents us from establishing consistent industry definitions for each year over the twenty-year period.

[20]See Dunne and Roberts (1986) and Dunne, Roberts, and Samuelson (1988b) for discussion of the plant matching process.

[21]The definition of small varies across industries and time but generally includes all plants with less than five employees. From 1967 onward most data

for these small plants has been imputed from other government sources whereas larger plants are surveyed directly.

[22]The twenty five industry dummies are included to distinguish the twenty six four-digit industries. Three time period dummies are included to distinguish observations in the four years (1967, 1972, 1977, and 1982). In these regressions there are a total of 104 (= 26·4) observations. The data from the 1963 census cannot be used in these entry regressions.

[23]For the 1963 firms it is not possible to separately identify age and year effects because each firm's age in 1963 is unknown. When summarizing the 1963 firms the regression model deletes the age variables and all aging effects are captured by the time-period dummy variables. For these firms, the first column in Table 3, which reports the results for the initial entry year, contains the average of the industry effects in 1967. The remaining three columns report the changes from 1967 in each of the next three census years.

[24]This does not mean that the firms which have survived have grown to the average size of all firms. The increase in average size could result from the failure of the smaller than average members of the entering cohort. This difference between growth of the surviving members and failure of the smaller firms will be examined in Section VI.

[25]The average size of these firms, however, is still substantially less than the average size of the older producers which were first observed in operation in the 1963 census.

[26]If the number of firms in the industry is growing, a cohort's share of the total number of firms must decline even if there is no failure. What is striking in these results are the differences in the magnitude of the decline across entrant categories. Results in the next section will show these arise from substantial differences in failure rates across entrant categories.

[27]Approximately five percent of the observations had values of the failure rate equal to zero, indicating no failure, and an additional five percent were equal to one, indicating complete failure of a group of firms. To account for these limiting observations, a two-limit Tobit model was estimated for the failure rate variable. The results from the Tobit model are reported in table A9 and used to construct the summary measures in the bottom part of Table 4.

[28]A set of 25 industry dummy variables was included in each of the regressions reported in the appendix. The industry coefficients are not reported here because of the confidentiality requirements placed on the data set by the Census Bureau. Instead, the F-statistic for the null hypothesis that all industry dummy variables are jointly equal to zero is reported in the last row of each table. The failure rate regressions in table A9 are estimated using the Tobit maximum likelihood estimator and the likelihood-ratio test statistic is reported.

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Table 2

Output Shares, Average Sizes, and Proportions of Entrant and Incumbent Firms

Mean values over industries and years
(Standard errors in parentheses)

	Output Share $SQ_j(i,t)$	Relative Average Size $RSE_j(i,t)$	Share of Number of Firms $SN_j(i,t)$
Incumbent Firms:	.907 (.026)*	1.676 (.121)*	.558 (.033)*
Entrants			
Total	.093 (.026)*	.217 (.057)*	.442 (.033)*
New/SP	.020 (.001)*	.101 (.005)*	.208 (.006)*
New/MP	.017 (.001)*	.398 (.030)*	.044 (.002)*
Div/SP	.009 (.001)*	.100 (.005)*	.092 (.003)*
Div/MP/NP	.025 (.003)*	.782 (.159)*	.042 (.002)*
Div/MP/PM	.023 (.002)*	.537 (.069)*	.060 (.002)*

*statistically significant at the $\alpha = .05$ level

Table 3

Aging Patterns for Entering Firms

Mean values over industries and years
(Standard errors in parentheses)

	Initial Entry Year	Change from initial entry year for firms of age		
Firm Age:	0-4 years	5-9 years	10-14 years	15-19 years
Output Share: $SQ_j(i,t)$				
Entrants: Total	.093 (.005)*	-.021 (.008)*	-.015 (.009)	-.042 (.012)*
New/SP	.021 (.001)*	-.009 (.001)*	-.015 (.002)*	-.019 (.002)*
Div/SP	.009 (.001)*	-.005 (.001)*	.007 (.001)*	-.010 (.001)*
New/MP	.018 (.001)*	-.004 (.002)	-.000 (.003)	-.007 (.004)
Div/MP/NP	.028 (.003)*	-.003 (.005)	-.007 (.006)	-.004 (.008)
Div/MP/PM	.022 (.002)*	-.002 (.003)	-.001 (.004)	-.001 (.005)
1963 Firms: SP	.076 (.005)*	-.040 (.006)*	-.051 (.006)*	-.063 (.007)*
MP	.842 (.012)*	-.063 (.015)*	-.106 (.016)*	-.139 (.018)*
Average Size Relative to all Firms in the Industry: $RSE_j(i,t)$				
Entrants: Total	.209 (.039)*	.248 (.059)*	.652 (.069)*	.817 (.091)*
New/SP	.099 (.009)*	.033 (.013)*	.065 (.016)*	.070 (.022)*
Div/SP	.111 (.018)*	.062 (.027)*	.069 (.033)*	-.048 (.045)
New/MP	.394 (.064)*	.199 (.098)*	.712 (.119)*	.803 (.168)*
Div/MP/NP	.796 (.229)*	.639 (.348)	1.512 (.416)*	1.884 (.556)*
Div/MP/PM	.473 (.122)*	.516 (.186)*	1.228 (.221)*	1.502 (.297)*
1963 Firms: SP	.196 (.060)*	.032 (.081)	.102 (.084)	.094 (.095)
MP	3.35 (.163)*	.718 (.216)*	1.436 (.222)*	2.322 (.256)*
Share of Number of Firms: $SN_j(i,t)$				
Entrants: Total	.457 (.007)*	-.305 (.010)*	-.381 (.012)*	-.429 (.010)*
New/SP	.216 (.005)*	-.146 (.007)*	-.191 (.009)*	-.206 (.012)*
Div/SP	.097 (.003)*	-.072 (.005)*	-.087 (.006)*	-.107 (.009)*
New/MP	.049 (.002)*	-.030 (.003)*	-.033 (.004)*	-.040 (.005)*
Div/MP/NP	.043 (.002)*	-.025 (.003)*	-.024 (.003)*	-.029 (.004)*
Div/MP/PM	.062 (.002)*	-.038 (.003)*	-.052 (.004)*	-.055 (.005)*
1963 Firms: SP	.341 (.012)*	-.160 (.016)*	-.231 (.017)*	-.287 (.019)*
MP	.299 (.011)*	-.060 (.015)*	-.107 (.015)*	-.141 (.018)*

*statistically significant at $\alpha = .05$ level

Table 4

Continuing and Exiting Firms in a Cohort

Mean values over industries and years
(Standard errors in parentheses)

		Base: First five year period of observation	Change from the base for firms in years of observation 6-10	11-14	15-19
Change in the Average Size of Continuing Firms					
Entrants:	Total	.145 (.048)*	.013 (.077)	-.012 (.103)	
	New/SP	.046 (.011)*	-.002 (.020)	-.063 (.024)*	
	Div/SP	.038 (.015)*	-.000 (.025)	-.019 (.039)	
	New/MP	.208 (.110)	.139 (.180)	-.275 (.280)	
	Div/MP/NP	.588 (.205)*	-.331 (.328)	.148 (.473)	
	Div/MP/PM	.264 (.159)	.261 (.269)	-.505 (.358)	
1963 Firms:	SP	.028 (.060)	-.030 (.081)	.046 (.082)	-.117 (.093)
	MP	.533 (.139)*	.618 (.184)*	.279 (.190)	.405 (.219)
Difference in the Average Size of Continuing and Exiting Firms					
Entrants:	Total	.241 (.055)*	.364 (.090)*	.429 (.119)*	
	New/SP	.012 (.017)	.015 (.029)	-.012 (.042)*	
	Div/SP	.066 (.030)*	-.105 (.054)*	-.130 (.073)	
	New/MP	.209 (.084)*	.229 (.151)	.558 (.226)*	
	Div/MP/NP	.819 (.325)*	1.07 (.017)	1.75 (.879)*	
	Div/MP/PM	.551 (.183)*	.587 (.339)	1.16 (.494)*	
1963 Firms:	SP	.082 (.046)*	-.050 (.063)	-.008 (.065)	.030 (.073)
	MP	3.03 (.188)*	.399 (.248)	1.00 (.255)*	1.50 (.292)*
Failure Rate					
Entrants:	Total	.615 (.019)*	-.194 (.026)*	-.240 (.034)*	
	New/SP	.625 (.019)*	-.067 (.037)	-.113 (.048)*	
	Div/SP	.689 (.029)*	-.207 (.071)*	-.011 (.093)	
	New/MP	.574 (.031)*	-.201 (.072)*	-.214 (.077)*	
	Div/MP/NP	.495 (.028)*	-.304 (.067)*	-.283 (.084)*	
	Div/MP/PM	.522 (.027)*	-.218 (.059)*	-.385 (.080)*	
1963 Firms:	SP	.500 (.036)*	.020 (.053)	-.162 (.054)*	.075 (.061)
	MP	.243 (.014)*	-.019 (.020)	-.083 (.021)*	-.095 (.025)*

*statistically significant at $\alpha = .05$ level

Appendix: Tables of Regression Coefficients[28]

Table A1

Output Share of Entrant and Incumbent Firms $SQ_j(i,t)$
(standard errors in parentheses)

	Incumbent Firms	Entrant Firms					
		Total	New/SP	Div/SP	New/MP	Div/MP/NP	Div/MP/PM
Intercept	.977* (.027)	.023 (.027)	.004 (.005)	.005* (.003)	-.001 (.006)	.001 (.019)	.014 (.010)
Year 1972	-.037* (.014)	.037* (.014)	.001 (.003)	-.001 (.001)	.014* (.003)	.032* (.010)	-.009 (.005)
1977	.014 (.015)	-.014 (.015)	-.001 (.003)	-.001 (.001)	-.003 (.003)	-.008 (.010)	-.002 (.005)
1982	.003 (.017)	-.003 (.017)	.001 (.003)	.001 (.001)	.009 (.004)	-.006 (.011)	-.008 (.006)
Growth	.095 (.204)	-.094 (.204)	.015 (.037)	.009 (.020)	.142* (.048)	-.180 (.141)	-.080 (.076)
$Growth^2$	-.585 (1.66)	.585 (1.66)	-.364 .304	-.034 (.165)	-1.01* (.387)	.817 (1.15)	1.171* (.613)
F-statistic No industry effects:	3.91*	3.91*	12.68*	10.06*	4.37*	1.88*	3.69*

*statistically significant at $\alpha = .05$ level

Table A2

Relative Average Size of Entrant and Incumbent Firms $RSE_j(i,t)$

(standard errors in parentheses)

	Incumbent Firms	Entrant Firms					
		Total	New/SP	Div/SP	New/MP	Div/MP/NP	Div/MP/PM
Intercept	1.86* (.128)	.085 (.061)	.051 (.029)	.059* (.030)	.157 (.164)	.176 (.884)	.354 (.371)
Year 1972	.157* (.068)	.034 (.032)	-.028 (.016)	.008 (.016)	-.027 (.086)	.663 (.466)	-.272 (.198)
1977	.141* (.070)	-.070 (.033)	-.037 (.016)	.037* (.016)	-.195* (.089)	-.468 (.480)	-.261 (.204)
1982	.311* (.080)	-.068 (.038)	-.029 (.018)	-.020 (.018)	.179 (.102)	-.382 (.553)	-.420 (.235)
Growth	.141 (.965)	-.526 (.457)	.054 (.222)	-.452 (.222)	2.08 (1.24)	-6.40 (6.66)	-2.91 (2.83)
$Growth^2$	-.331 (7.86)	3.30 (3.72)	-1.56 (1.81)	2.54 (1.81)	-12.56 (10.05)	5.95 (54.21)	49.37* (23.01)
F-statistic No industry effects:	4.34*	4.38*	6.67*	8.61*	4.06*	1.14	1.91*

*statistically significant at $\alpha = .05$ level

Table A3

Share of the Number of Firms $SN_j(i,t)$

	Incumbent Firms	Entrant Firms					
		Total	New/SP	Div/SP	New/MP	Div/MP/NP	Div/MP/PM
Intercept	.555* (.035)	.444* (.035)	.120* (.031)	.135* (.018)	.018 (.011)	.073* (.011)	.098* (.013)
Year 1972	-.085* (.019)	.085* (.019)	.036* (.016)	-.012 (.010)	.039* (.006)	.026* (.006)	-.003 (.007)
1977	-.048* (.019)	.048* (.019)	.048* (.017)	-.025* (.010)	.008 (.006)	-.002 (.006)	.020* (.007)
1982	-.108* (.022)	.108* (.022)	.037 (.019)	.044* (.011)	.010 (.007)	-.004 (.007)	.022* (.008)
Growth	-.128 (.266)	.128* (.266)	-0.312 (.233)	.241 (.138)	.179* (.086)	-.007 (.086)	.031 (.098)
$Growth^2$	1.85 (2.16)	-1.85 (2.16)	1.78 (.190)	-2.66* (1.13)	-1.73* (.702)	.240 (.700)	.510 (.792)
F-statistic No industry effects:	4.57*	4.57*	4.67*	6.68*	1.98*	3.27*	7.29*

*statistically significant at $\alpha = .05$ level

Table A4

Output Share By Entering Cohort $SQ_j(i,t)$

(standard errors in parentheses)

	1963 Firms		1967, 1972, 1977, and 1982 Entrants					
	SP	MP	Total	New/SP	Div/SP	New/MP	Div/MP/NP	Div/MP/PM
Intercept	.003	.986*	.045*	.006*	.006*	.008	-.007	.027*
	(.021)	(.029)	(.018)	(.003)	(.002)	(.006)	(.012)	(.007)
Year 1972	-.040*	-.063*	.016	.001	-.002	.006	.020*	-.007
	(.006)	(.015)	(.012)	(.002)	(.001)	(.004)	(.008)	(.005)
1977	-.051*	-.106*	.003	.002	-.001	.002	.012	-.006
	(.006)	(.016)	(.012)	(.002)	(.001)	(.004)	(.008)	(.005)
1982	-.063*	-.139*	.002	.002	-.000	.003	.007	-.006
	(.007)	(.018)	(.013)	(.002)	(.001)	(.004)	(.009)	(.005)
Age 5-9 years			-.021*	-.009*	-.005*	-.004	-.003	-.002
			(.008)	(.001)	(.001)	(.002)	(.005)	(.003)
10-14 years			-.015	-.015*	-.007*	-.000	-.007	-.001
			(.009)	(.002)	(.001)	(.003)	(.006)	(.004)
15-19 years			-.042*	-.019*	-.010*	-.007	-.004	-.001
			(.012)	(.002)	(.001)	(.004)	(.008)	(.005)
Growth	-.064	.110	.013	.009	-.006	.077*	-.061	.028
	(.086)	(.220)	(.116)	(.020)	(.012)	(.035)	(.080)	(.046)
$Growth^2$	-.680	.238	-.640	-.362*	.012	-.669*	.199	-.070
	(.693)	(1.79)	(1.00)	(.169)	(.108)	(.311)	(.693)	(.400)
F-statistic No industry effects:	12.48*	22.89*	9.34*	21.06*	11.41*	6.06*	5.89*	5.20*

*statistically significant at $\alpha = .05$ level

Table A5

Relative Average Size By Entering Cohort $RSE_j(i,t)$

(standard errors in parentheses)

	1963 Firms		1967, 1972, 1977, and 1982 Entrants					
	SP	MP	Total	New/SP	Div/SP	New/MP	Div/MP/NP	Div/MP/PM
Intercept	-.031 (.271)	1.52* (.401)	.099 (.139)	.020 (.033)	.022 (.067)	.400 (.248)	-.479 (.809)	.630 (.434)
Year 1972	.032 (.081)	.718* (.216)	.012 (.095)	-.024 (.021)	-.021 (.043)	-.011 (.160)	.453 (.553)	-.375 (.300)
1977	.102 (.084)	1.436* (.223)	-.064 (.095)	-.014 (.021)	-.015 (.043)	-.110 (.161)	-.051 (.556)	-.375 (.300)
1982	.094 (.095)	2.322* (.256)	-.054 (.103)	-.024 (.023)	-.017 (.047)	-.078 (.173)	-.495 (.608)	-.386 (.327)
Age 5-9 years			.248* (.059)	.033* (.013)	.062* (.027)	.199* (.098)	.639 (.348)	.516* (.186)
10-14 years			.652* (.069)	.065* (.016)	.069* (.033)	.712* (.119)	1.51* (.416)	1.23* (.122)
15-19 years			.817* (.091)	.070* (.022)	-.048 (.045)	.803* (.168)	1.88* (.556)	1.50* (.297)
Growth	1.63 (1.13)	5.95* (3.08)	-.256 (.891)	.116 (.201)	-.662 (.430)	1.95 (1.53)	-5.84 (5.39)	2.68 (2.87)
$Growth^2$	-21.36* (9.10)	-73.06* (25.14)	-.010 (7.73)	-2.19 (1.73)	-.882 (3.93)	-17.42 (13.46)	-3.52 (46.39)	-27.37 (24.84)
F-statistic No industry effects:	6.62*	28.98*	5.41*	9.96*	4.92*	5.40*	3.59*	2.90*

*statistically significant at $\alpha = .05$ level

Table A6

Share of Number of Firms by Entering Cohort $SN_j(i,t)$

(standard errors in parentheses)

	1963 Firms		1967, 1972, 1977, and 1982 Entrants					
	SP	MP	Total	New/SP	Div/SP	New/MP	Div/MP/NP	Div/MP/PM
Intercept	.007 (.054)	.424* (.028)	.395* (.025)	.125* (.019)	.110* (.013)	.021* (.008)	.060* (.006)	.079* (.008)
Year 1972	-.160* (.016)	-.060* (.015)	.068* (.017)	.032* (.012)	-.007 (.008)	.023* (.005)	.016* (.004)	.004 (.005)
1977	-.231* (.017)	-.107* (.015)	.082* (.017)	.054* (.012)	-.006 (.008)	.015* (.005)	.010* (.004)	.015* (.005)
1982	-.287* (.019)	-.141* (.018)	.097* (.018)	.046* (.013)	.017 (.009)	.014* (.005)	.005 (.005)	.019* (.006)
Age 5-9 years			-.305* (.010)	-.146* (.007)	-.072* (.005)	-.030* (.003)	-.025* (.002)	-.038* (.003)
10-14 years			-.381* (.012)	-.191* (.009)	-.087* (.006)	-.033* (.004)	-.024* (.003)	-.052* (.004)
15-19 years			-.429* (.016)	-.206* (.012)	-.107* (.009)	-.040* (.005)	-.029* (.004)	-.055* (.005)
Growth	-.272 (.224)	.089 (.214)	.115 (.157)	-.140 (.112)	.086 (.081)	.084 (.047)	.036 (.041)	.075 (.050)
$Growth^2$	1.60 (1.81)	1.62 (1.74)	-1.23 (1.37)	.578 (.969)	-6.87 (.748)	-.714 (.412)	-.004 (.356)	-.038 (.437)
F-statistic No industry effects:	17.52*	14.26*	1.46	6.90*	4.60*	2.16*	6.36*	8.60*

*statistically significant at $\alpha = .05$ level

Table A7

Change in Average Size of Surviving Firms $\left(\frac{Q_j^c(i,t+1)}{N_j^c(i,t+1)} - \frac{Q_j^c(i,t)}{N_j^c(i,t)}\right) / \left(\frac{Q(i,t)}{N(i,t)}\right)$

(standard errors in parentheses)

	1963 Firms		1967, 1972, 1977, and 1982 Entrants					
	SP	MP	Total	New/SP	Div/SP	New/MP	Div/MP/NP	Div/MP/PM
Intercept	.101 (.156)	-.534 (.349)	.166 (.173)	.020 (.060)	-.042 (.115)	.908 (.588)	-.003 (.707)	.878 (.566)
Initial Year								
1967	-.030 (.081)	.618* (.184)						
1972	.046 (.082)	.279 (.190)	.007 (.113)	-.010 (.026)	.023 (.038)	.184 (.273)	.731 (.515)	-.595 (.406)
1977	-.117 (.093)	.405 (.219)	-.033 (.085)	.005 (.020)	.030 (.028)	-.159 (.200)	-.170 (.383)	-.385 (.310)
Initial Age								
5-9 years			.013 (.077)	-.002 (.020)	-.000 (.025)	.139 (.180)	-.331 (.328)	.261 (.269)
10-14 years			-.012 (.103)	-.063 (.024)	-.019 (.039)	-.275 (.280)	.148 (.473)	-.505 (.358)
Growth	.543 (1.12)	20.11* (2.63)	4.19* (1.22)	.051 (2.78)	.134 (.442)	12.28* (2.95)	6.00 (6.26)	13.42* (5.29)
$Growth^2$	-1.28 (9.01)	13.70 (21.42)	-4.06 (12.18)	2.55 (2.67)	2.56 (4.04)	-64.51* (31.70)	49.83 (58.91)	-110.84* (54.20)
F-statistic No industry effects:	.242	2.55*	.988	.615	3.97*	4.20*	.871	.906

*statistically significant at $\alpha = .05$ level

Table A8

Difference in the Average Size of Surviving and Exiting Firms $\left(\frac{Q_j^c(i,t)}{N_j^c(i,t)} - \frac{Q_j^x(i,t)}{N_j^x(i,t)}\right) / \left(\frac{Q(i,t)}{N(i,t)}\right)$

(standard errors in parentheses)

	1963 Firms		1967, 1972, 1977, and 1982 Entrants					
	SP	MP	Total	New/SP	Div/SP	New/MP	Div/MP/NP	Div/MP/PM
Intercept	-.088 (.205)	1.58* (.465)	.014 (.199)	-.037 (.073)	.030 (.129)	-.218 (.401)	-.204 (1.54)	-.159 (.714)
Initial Year								
1967	-.050 (.063)	.399 (.248)						
1972	-.008 (.065)	1.00* (.255)	.026 (.129)	.004 (.041)	.040 (.077)	.254 (.206)	.199 (.820)	.427 (.459)
1977	.030 (.073)	1.50* (.292)	.047 (.099)	.033 (.032)	-.005 (.060)	.384 (.160)	.807 (.676)	.166 (.374)
Initial Age								
5-9 years			.364* (.090)	.015 (.029)	-.105* (.054)	.229 (.151)	1.07 (.617)	.587 (.339)
10-14 years			.429* (.119)	-.012 (.042)	-.130 (.073)	.558* (.226)	1.75* (.879)	1.16* (.494)
Growth	3.67* (.897)	1.64 (3.53)	-.028 (1.44)	-.305 (.467)	-1.76 (.923)	-4.86* (2.31)	-3.10 (9.62)	6.12 (5.46)
Growth^2	-31.55* (7.21)	-18.35 (28.79)	5.10 (14.37)	5.11 (4.56)	4.65 (8.66)	38.25 (23.81)	-42.56 (95.46)	-55.96 (51.61)
F-statistic No industry effects:	1.98*	20.59*	3.78*	.555	.934	2.33*	2.81*	2.12*

*statistically significant at $\alpha = .05$ level

Table A9

Cohort Failure Rates $\frac{N_j^x(i,t)}{N_j(i,t)}$

(standard errors in parentheses)

	1963 Firms		1967, 1972, 1977, and 1982 Entrants					
	SP	MP	Total	New/SP	Div/SP	New/MP	Div/MP/NP	Div/MP/PM
Intercept	.991*	.164	.708*	.967*	1.27*	.828*	.333*	.501*
	(.174)	(.094)	(.062)	(.070)	(.145)	(.128)	(.107)	(.104)
Year 1972	.020	-.019						
	(.053)	(.020)						
1977	-.162*	-.083*	-.111*	-.154*	-.102	-.131	-.032	-.068
	(.054)	(.021)	(.035)	(.055)	(.119)	(.115)	(.084)	(.075)
1982	.075	-.095*	-.002	-.048	-.018	.009	-.003	-.013
	(.061)	(.025)	(.036)	(.061)	(.135)	(.111)	(.089)	(.083)
Age 5-9 years			-.194*	-.067	-.207*	-.201*	-.304*	-.218*
			(.026)	(.037)	(.071)	(.072)	(.067)	(.059)
10-14 years			-.240*	-.113*	-.011	-.214*	-.283*	-.385*
			(.034)	(.048)	(.093)	(.077)	(.084)	(.080)
Growth	.506	-.225	.947	-.482	-.755	.265	-.950	-1.19
	(.730)	(.276)	(.723)	(.439)	(1.20)	(1.10)	(1.05)	(.763)
$Growth^2$	-7.42	.854	-5.62	8.13	8.30	4.98	2.78	12.40
	(5.87)	(2.41)	(5.81)	(5.92)	(15.38)	(11.19)	(10.40)	(8.16)
LR-statistic No industry effects:	42.04*	52.52*	69.19*	90.28*	47.22*	39.87*	36.45	37.32*

*statistically significant at $\alpha = .05$ level